

SILICA FUME MODIFIED STRUCTURAL CONCRETE BRIDGE DECK OVERLAY

The Standard Specifications are revised as follows:

SECTION 733, BEGIN LINE 1, INSERT AS FOLLOWS:

***SILICA FUME MODIFIED STRUCTURAL CONCRETE BRIDGE DECK
OVERLAY***

733.01 Description. This work shall consist of placing silica fume modified concrete, SFMC, for structures and incidental construction in accordance with 105.03.

MATERIALS

10 ***733.02 Materials.*** Materials shall be in accordance with 702.03 and the following.

Coarse Aggregate, Class A or Higher, Size No.11 *.....904
PCC Sealer/Healer901.06
Silica Fume901.04
* Crushed stone only

20 ***733.03 Shipping and Storage.*** Shipping and storage shall be in accordance with 702.04 for portland cement. Liquid silica fume slurry or dry condensed silica fume shall be shipped and stored as recommended by the manufacturer.

733.04 Proportioning. The proportioning of ingredients for each batch of SFMC shall be in accordance with 702.05 except as modified below and shall meet the mix design, trial batch demonstration, and job-use requirements as specified herein.

The portland cement content shall be 390 kg/m³ (658 lbs/yd³). Silica fume shall be added at 30 kg/m³ (50 lb/yd³).

30 The SFMC shall utilize an approved a type F or G admixture to be combined with an air entraining admixture, AEA, a HRWR Admixture System or a HRWRR Admixture System shall be selected from the Department's list of approved PCC Admixtures and Admixture Systems

The water/cementitious ratio shall be no less than 0.370 and shall not exceed 0.400, as measured in accordance with Departmental procedures. Portland cement and silica fume shall be included in the total amount of cementitious material.

40 The same brand of cement and silica fume shall be used throughout the structure. The HRWR or HRWRR admixture system shall not be changed during any individual contiguous pour.

The Contractor shall obtain a written statement from each admixture manufacturer stating the compatibility of the HRWR admixture system and satisfactory performance in SFMC.

50 *The SFMC shall have a relative yield and air content as specified in 702.05. The slump will be tested in accordance with AASHTO T 119 at the time of placement and shall be 113 to 188 mm (4.5 to 7.5 in.). The SFMC shall have the ability to hold the profile grade and cross slope shown on the plans. The SFMC shall have a minimum compressive strength of 31 000 kPa (4500 psi) at seven days and 37 800 kPa (5500 psi) at 28 days. The compressive strength shall be in accordance with 702.24.*

60 *An acceptable mix design shall be submitted at least 40 days prior to initiating the work. All material sources for components of the SFMC shall be identified in the mix design. Specific gravities shall be provided for the cement and silica fume along with SSD bulk specific gravity and absorptions for the fine and coarse aggregate. Values will be checked against source records maintained by the Materials and Tests Division for accuracy. A discrepancy beyond the D2S range for multi-laboratory precision shall be resolved by testing the aggregates according to 904 and AASHTO T 84, whichever is applicable to substantiate absorption and bulk specific gravity for the mix design. The manufacturer of the AEA, and the chemical admixtures included in the HRWR or HRWR admixture systems shall furnish data that relates the recommended addition rates to ambient temperature. The design addition rates shall be based on this data and the anticipated ambient and concrete temperature at time of placement.*

70 **733.05 Trial Batch.** *A trial batch is required to verify that the mix design will produce concrete complying with the physical properties specified, as well as simulating the placement properties unique to the conditions of the contract such as profile grade, cross slope, delivery time, discharge rate, and slump loss with time. The Contractor's American Concrete Institute, ACI, certified concrete field-testing technician, grade 1, shall perform all testing of the trial batch concrete.*

The demonstration shall include a meeting between the Contractor, material suppliers, and Department to discuss SFMC, batching, mixing, delivery, placement, finishing, and curing. Representatives from the silica fume and chemical admixture manufacturer(s) shall be present for trial batch demonstrations and the start-up for initial bridge deck placement. The Engineer may waive the required attendance for these representatives if the Contractor provides sufficient evidence of adequate experience with producing and placing SFMC.

80 **733.06 Batching.** *Batching shall be in accordance with 702.06 except the minimum batch shall be 3 m³ (4 yd³) and the maximum shall not exceed 80% of the trucks rated capacity. Dry condensed silica fume shall be either sacked or bulk and it shall be batched in accordance with the requirements for cement as specified in 702.06. However, no partial sack of dry condensed silica fume shall be used in a batch of SFMC. Dry condensed silica fume is typically added after the initial water and aggregates, with premixing prior to the addition of cement and fly ash, to facilitate dispersion. An alternate batching sequence will be allowed as recommended by the manufacturer of the silica fume and approved by the Engineer. Liquid silica fume slurry shall be batched as required by the manufacturer and as approved by the engineer. The AEA shall be added initially with either the first portion of mix water or*

90

the fine aggregate. If a Type A or D chemical admixture is used as part of the approved HRWR admixture system: it shall be added separately with a portion of the mix water, after the AEA is premixed in the concrete. A type F or G chemical admixture shall be added separately at the end of the batching sequence with some mix water held in reserve to aid dispersion.

A change in the sequence of batching will be approved if it is in accordance with the chemical admixture and silica fume manufacturer's recommendations; and is agreed to in writing prior to any trial batch demonstration.

100

733.07 Mixing. *Mixing shall conform to 702.09(a), 702.09(b), and 702.09(c), except mixing time shall be a minimum of 84 s. Retempering SFMC by adding water or by other means will not be permitted after 30 min from initial batching and mixing. When concrete is delivered in transit mixers, additional water may be permitted to increase a marginally low slump. Water shall not be added once 10% of the load has been discharged. Additional mixing shall be performed as directed and all operations completed within the time limits in accordance with 702.09(c). The amount of water shall be determined accurately and noted on the batch ticket. Such addition of water will not be permitted as a continuing operation. The total of all water included in the*

110

CONSTRUCTION REQUIREMENTS

733.08 General. *Construction operations as applicable shall be in accordance with 722.*

733.09 Placing and Finishing. *The concrete shall not be placed unless the ambient temperature is 7°C (45°F) and rising, unless otherwise approved in writing. Placement may be required during early morning hours, at night, or during other*

120

limited work periods if the prevailing daytime temperature exceeds 29°C (85°F). The concrete shall not be placed if rain is expected within 4 h. Adequate precautions shall be taken to protect freshly placed concrete material from sudden or unexpected rain. Damaged material shall be removed and replaced with no additional payment.

An evaporation retardant shall be applied to the exposed SFMC surface immediately after finishing or texturing and in accordance with the manufacturer's recommendation. Reapplication of the retardant shall be performed whenever the surface is disturbed, or when drying of the surface is observed. The evaporation retardant system shall be provided from products listed on the Department's list of

130

A type C certification in accordance with 916 for the evaporative retardant shall be submitted to the Engineer prior to use.

The rate of water evaporation shall be determined during placement in accordance with ACI 308, Section 1.2.1. or the following equation:

$$E = 5[(T_c + 18)^{2.5} - r(T_a + 18)^{2.5}][V + 4] \times 10^6$$

$$(E = [T_c^{2.5} - (r \times T_a^{2.5})][1 + 0.4V] \times 10^6)$$

140

where:

E = Evaporation rate, kg/m²/h (lb/ft²/h)

T_c = Concrete temperature, °C (°F)

T_a = Ambient temperature, °C (°F)

r = (RH %)/100

V = Wind velocity, k/h (mi/h)

150

Measurement of T_a , r , and V shall be obtained on-site from readings made by the local weather bureau or Contractor measurements made on site. Measurement of T_c shall be determined from the concrete on site at the point of placement. If the evaporation rate exceeds 0.50 kg/m²/h (0.10 lbs/ft²/h) fog misting, as recommended by the silica fume manufacturer, shall be performed after the finishing operation and prior to the wet cure. Fog misting shall keep the environment above the concrete surface at high humidity to protect against plastic shrinkage cracks and shall not be used to apply water directly to the surface to facilitate finishing.

160

Membrane forming curing compounds shall not be used to cure the bridge deck. The curing period shall be seven calendar days and a minimum compressive strength of 31 000 kPa (4500 psi). Strength requirements and making and forming of cylinders shall be in accordance with 702.24. The seven day curing period will not be waived based on strength gain. After texturing, the surface of the overlay shall be protected from shrinkage cracking with a single layer of well-drained wet burlap. This layer of wet burlap shall be placed as soon as the overlay surface will support it without deformation. Approximately 1 h after placing the first layer of wet burlap, a second layer shall be placed and the entire covering shall be maintained in a wet condition for a minimum of 96 h through the use of soaker hoses. Polyethylene sheeting may be used in lieu of the second layer of wet burlap.

170

After the seven calendar days have elapsed, all layers of curing material shall be removed. If the ambient temperature falls below 10°C (50°F), the time that the temperature is below 10°C (50°F) shall not be considered as part of the curing period.

Immediately after the cure period, the surface will be checked for cracks. If cracks are found to be greater than 0.5 mm (0.02 in.) in width, the cracks shall be sealed with an approved sealer/healer. The sealant shall be fed by gravity into the crack. Material shall be contained by the use of dams, or by routing a groove or slot over the crack.

180

733.10 Frequency of Sampling and Testing. Acceptance sampling and testing of the SFMC will be completed according to the frequencies defined herein. The water/cementitious ratio shall be determined soon after the pour begins for each day of placement, or if there is a significant change in the aggregate moisture content. Absorptions for water/cementitious ratio determination will be measured from the actual stockpiles of aggregates used. As a minimum, the relative yield, air content,

slump, and compressive strength will be determined on the first load accepted for placement. Air content, slump, and compressive strength will be determined on every third load delivered thereafter. Evaporation rate will be monitored throughout placement.

190 **733.11 Method of Measurement.** *This work will be measured in accordance with 722.13.*

733.12 Basis of Payment. *This work will be paid for in accordance with 722.14.*
